UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2002/2003

Februari – Mac 2003

ZCT 535/4 – Perubatan Nuklear dan Fizik Radioterapi

Masa : 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.

Jawab kesemua LIMA soalan. Pelajar dibenarkan menjawab semua soalan dalam Bahasa Inggeris ATAU Bahasa Malaysia ATAU kombinasi kedua-duanya.

Bahagian A
(Sila jawab dalam masa 1½ jam).

1. (a) Huraikan maksud ungkapan berikut:

(i) peratus dos kedalaman pada paksi pusat.

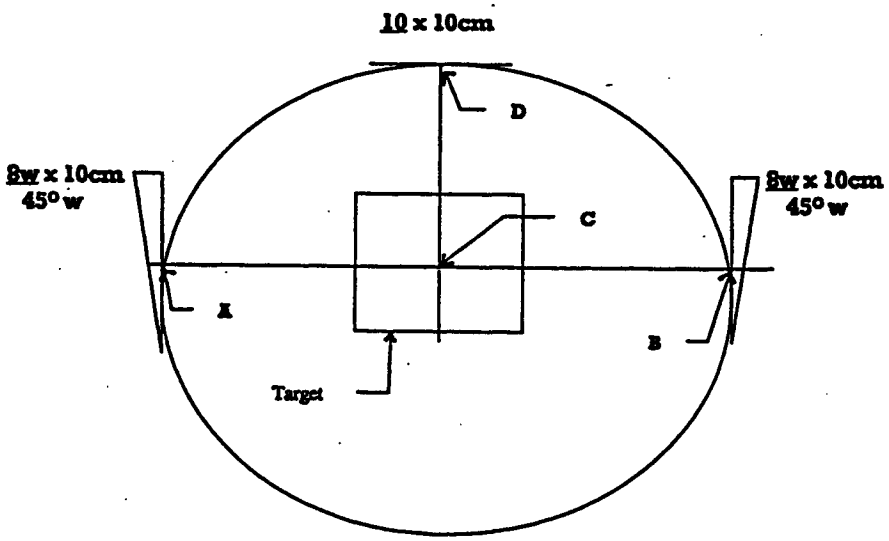
(ii) Nisbah udara tisu.

(iii) Nisbah maksimum tisu.

Bagi suatu bim 10 MV foton yang menggunakan teknik isosentrik, anda gunakan TAR atau TMR. Mengapa?

(40/100)

(b) Seorang pesakit menerima rawatan pada abdomen dari tiga bim 10 MV foton, setiapnya dari 100 cm SSD seperti dibawah:



Dimensi adalah: AC 15 cm, BC = 15 cm, CD = 12 cm

% DD dan faktor output relatif pada 100 cm SSD untuk berapa julat saiz medan diberi dibawah:

	Field Size					
Depth (cm)	5x5 cm	6x6 cm	7x7 cm	8x8 cm	9x9 cm	10x10 cm
8	72.4	73.0	73.5	74.0	74.3	74.6
10	64.2	65.0	65.8	66.2	66.8	67.3
12	56.9	57.6	58.4	59.2	59.9	60.6
14	51.4	52.2	52.8	53.7	54.5	54.9
16	45.5	46.5	47.2	47.9	48.7	49.3
Output Factor	1.06	1.05	1.03	1.02	1.01	1.00

Faktor 'wedge' untuk 45° wedge adalah 0.5

(i) Jika 10 MV diberi dari setiap bim, hitungkan dos dari setiap bim ke titik C. Tunjukkan perhitungan dengan teliti.

(ii) Jika titik C letaknya pada pusat isocentre bim, hitungkan dos dari setiap bim kepusat C.

(iii) Nyatakan fungsi wedge yang letaknya pada A dan B.

(60/100)

2. (a) Lakarkan pada skala yang sesuai (gunakan kertas graf) kurva peratus kedalaman dos pada paksi pusat untuk medan 10×10 cm^2 pada 100 cm SSD untuk 6 MV foton dan 6 MeV elektron. Terangkan mengapa dos maksimum berlaku dibawah permukaan bagi setiap bim.

(35/100)

(b) Bagaimana output dan dos kedalaman bagi bim-bim dalam (a) berubah dengan perubahan.

(i) SSD dari 100 cm ke 105 cm.
(ii) Saiz medan dari 10×10 cm^2 ke 15×15 cm^2.

Terangkan jawapan anda.

(35/100)

(c) Terangkan maksud brakiterapi. Bandingkan penggunaan sumber Cs-137 dan Ir-192 dalam rawatan kanser cervix.

(30/100)

Bahagian B (Sila jawab dalam masa 1½ jam).

3. (a) Secara ringkas terangkan

(i) tiga (3) parameter pelaksanaan kamera gamma (15/100)

(ii) tiga (3) faktor yang mempengaruhi kualiti imej dalam imejan radioisotop mensatah (15/100)

(b) Apakah kebaikan SPECT jika dibandingkan dengan imejan radionuklid mensatah?

(20/100)

(c) Berdasarkan satu gambarajah jelaskan pembentukan imej dua sumber gamma kecil di dalam fantom dengan kaedah SPECT.

(15/100)

(d) Dalam SPECT bilakah masanya turas berfrekuensi ruang tinggi digunakan. Nyatakan kebaikan serta keburukan penggunaan turas tersebut. (15/100

(e) Secara ringkas jelaskan bagaimana aktiviti di dalam suatu organ dapat dihitung dengan kaedah SPECT. (20/100)

4. (a) Secara ringkas terangkan

(i) dua (2) mod reputan radioaktif (10/100)
(ii) separuh hayat biologi dan separuh hayat efektif (10/100)
(iii) kenapa Tc-99m digunakan secara meluas untuk imejan (20/100)
(iv) operasi Mo-99/Tc-99m penjana (20/100)

(b) Lakarkan graf yang menunjukkan perubahan aktiviti anak dengan masa bagi tiga penjana radionuklid "fictitious" di mana

(i) Separuh hayat induk terlalu lama dibandingkan dengan separuh hayat anak. (10/100)

(ii) Separuh hayat induk tidak seberapa lama dibandingkan dengan separuh hayat anak. (10/100)

(iii) Separuh hayat induk terlalu singkat dibandingkan dengan separuh hayat anak. (20/100)

5. (a) Secara ringkas terangkan 3 faktor yang menyumbang kepada dos sinaran dalam organ sasaran daripada keradioaktifan dalam organ punca.

(15/100)

(b) Untuk sinaran menembus tuliskan maksud fizikal bagi sebutan-sebutan di dalam formula tersebut.

(20/100)

(c) 10 milliCurie Tc-99m + DTPA telah disuntik ke dalam pesakit untuk kajian ginjal. Untuk tempoh 30 minit daripada masa suntikan 50% daripada radiofarmaseutikal telah terkumpul dalam ginjal dan seterusnya dikeluarkan kepada pundi kencing dengan separuh hayat berkesan selama 30 minit. Dengan anggapan bahawa pengambilan (uptake) dalam ginjal adalah linear dengan masa, hitung dos min kepada ginjal.
Di beri S(gingal-ginjal) = 0.0046 rad/mikroCurie/hari.

(65/100)

TERJEMAHAN

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2002/2003 Academic Session

February – March 2003

ZCT 535/4 - Nuclear Medicine and Radiotherapy Physics

Time : 3 hours

Please check that the examination paper consists of **NINE** printed pages before you commence this examination.

Answer all FIVE questions. Students are allowed to answer all questions in English OR Bahasa Malaysia OR combinations of both.

Section A
(Answer in 1½ hours).

1. (a) Explain what is meant by:

(i) central axis percentage depth dose.

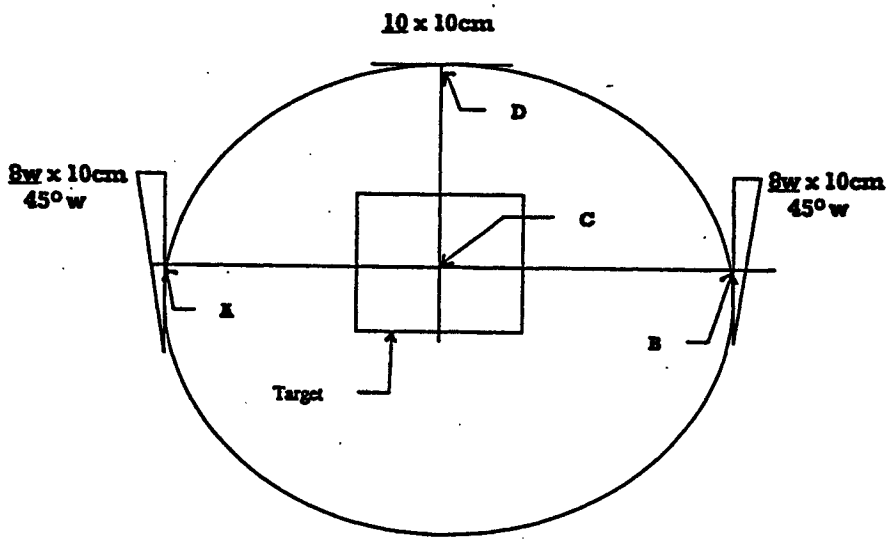
(ii) tissue air ratio (TAR)

(iii) tissue maximum ratio (TMR)

For a 10 MV photon beam using isocentric technique, would you use TAR or TMR. Why?

(40/100)

(b) A patient is to be treated to the abdomen with 3 beams of 10 MV photons, each at 100 cm SSD as shown below:



Dimensions are: AC 15 cm, BC = 15 cm, CD = 12 cm

% DD and relative output factors at 100 cm SSD for a range of field sizes are given below:

	Field Size					
Depth (cm)	5x5 cm	6x6 cm	7x7 cm	8x8 cm	9x9 cm	10x10 cm
8	72.4	73.0	73.5	74.0	74.3	74.6
10	64.2	65.0	65.8	66.2	66.8	67.3
12	56.9	57.6	58.4	59.2	59.9	60.6
14	51.4	52.2	52.8	53.7	54.5	54.9
16	45.5	46.5	47.2	47.9	48.7	49.3
Output Factor	1.06	1.05	1.03	1.02	1.01	1.00

Wedge factor for 45° wedge is 0.5

(i) If 10 MV are applied to each beam, how much dose does each beam give to point C? Show full details of your calculation.

(ii) If point C is at the isocentre of the beam, calculate the dose from each beam to point C.

(iii) State the function of the wedges placed at A and B.

(60/100)

2. (a) Draw to scale (use graph paper) the central axis percentage depth dose curves of 10×10 cm^2 fields at 100 cm SSD for 6 MV photons and 6 MeV electrons. Explain why the highest dose of each beam lies below the surface.

(35/100)

(b) How are the output and depth dose of these beams affected by a change in

(i) SSD from 100 cm to 105 cm.
(ii) Field size from 10×10 cm^2 to 15×15 cm^2.

Explain your answers.

(35/100)

(c) Explain the term brachytherapy. Compare the use Ir-192 and Cs-137 in the treatment of carcinoma of the cervix.

(30/100)

Section B (Answer in 1½ hours).

3. (a) Briefly describe

(i) 3 performance parameters of a gamma camera. (15/100)

(ii) 3 factors that contribute to the quality of the image in radioisotope planar imaging.

(15/100)

(b) What advantages has SPECT over planar radionuclide imaging?

(20/100)

(c) Explain, with the aid of diagrams, how the image of two gamma emitting small sources inside a body phantom would be reconstructed using SPECT.

(15/100)

(d) When would you use a high spatial frequency filter in SPECT reconstruction and what advantages and disadvantages has such a filter. (15/100)

(e) Briefly describe how the value of the activity in the organ is estimated in SPECT. (20/100)

4. (a) Briefly describe

(i) 2 modes of radioactive decay (10/100)
(ii) Biological half-life and effective half-life (10/100)
(iii) Why Tc-99m is widely used for imaging (20/100)
(iv) The mode of operation of Mo-99/Tc-99m generator (20/100)

(b) Sketch the graphical variation of daughter activity with time for three fictitious radionuclide generators where:

(i) The half-life of the parent is infinitely longer than the half-life of the daughter. (10/100)

(ii) The half-life of the parent is moderately longer than the half-life of the daughter. (10/100)

(iii) The half-life of the parent is much less than the half-life of the daughter. (20/100)

5. (a) Briefly explain 3 factors that contribute to the radiation dose in the target organ from radioactivity in the source organ. (15/100)

(b) For penetrating radiation write down the formula for the mean dose in the target organ and explain the physical meaning of the terms in the formula. (20/100)

(c) 10 milliCurie of Tc-99m +DTPA was injected into the patient for kidney study. Over a period of 30 minutes from injection time 40% of the total radiopharmacuetical injected was accumulated in the kidney and was then cleared to the bladder with effective half-life of 30 minutes. Assuming that the uptake in the kidney was linear with time, calculate the mean dose of the kidney due to the activity in the kidney. Given that S(kid-kid) = 0.0046 rad/microCurie/day. (65/100)

Table 11-7 6 MV percentage depth dose at 100 cm SSD

Eq Sq Depth (cm)	0.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	35.0
0.0	19.2	19.2	19.2	20.5	21.8	23.0	24.3	25.6	26.7	27.9	29.1	30.2	31.4	32.6	33.8	35.1	36.3	37.5	39.0	40.4	41.9	43.2	44.5	45.7	47.6
1.0	96.8	96.9	96.9	97.0	97.0	97.0	97.1	97.1	97.2	97.2	97.3	97.3	97.4	97.4	97.5	97.5	97.6	97.6	97.7	97.8	98.0	98.1	98.1	98.2	98.3
1.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2.0	97.4	98.2	98.4	98.4	98.5	98.5	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7
3.0	91.1	93.8	94.4	94.7	94.9	95.0	95.0	95.1	95.1	95.1	95.2	95.2	95.2	95.3	95.3	95.4	95.4	95.5	95.5	95.6	95.6	95.6	95.6	95.6	95.5
4.0	85.3	89.6	90.6	90.9	91.3	91.4	91.5	91.5	91.5	91.6	91.6	91.7	91.7	91.8	91.9	92.0	92.1	92.2	92.2	92.3	92.4	92.3	92.3	92.3	92.2
5.0	79.9	84.5	85.6	86.1	86.6	86.8	87.0	87.1	87.3	87.5	87.7	87.8	87.9	88.1	88.2	88.3	88.5	88.6	88.7	88.8	89.0	89.0	89.0	89.0	88.9
6.0	74.8	79.7	80.9	81.5	82.1	82.4	82.7	83.0	83.2	83.5	83.8	84.0	84.1	84.3	84.5	84.7	84.8	85.0	85.2	85.4	85.6	85.6	85.7	85.8	85.7
7.0	70.1	75.1	76.3	77.1	77.8	78.3	78.7	79.0	79.3	79.6	79.9	80.3	80.4	80.6	80.8	81.0	81.2	81.4	81.7	82.0	82.2	82.3	82.4	82.5	82.3
8.0	65.7	70.8	72.1	72.9	73.7	74.2	74.7	75.1	75.5	75.9	76.2	76.6	76.8	77.0	77.3	77.5	77.8	77.9	78.3	78.6	78.8	78.9	79.0	79.1	79.0
9.0	61.5	66.7	68.0	68.9	69.8	70.4	71.0	71.4	71.8	72.2	72.6	73.0	73.2	73.5	73.8	74.1	74.3	74.5	74.9	75.3	75.5	75.6	75.8	76.0	75.7
10.0	57.7	62.8	64.1	65.1	66.1	66.7	67.4	67.8	68.3	68.8	69.2	69.6	69.8	70.1	70.5	70.8	71.0	71.2	71.6	72.0	72.3	72.5	72.7	72.8	72.6
11.0	54.0	59.2	60.4	61.5	62.4	63.1	63.8	64.2	64.8	65.3	65.8	66.1	66.4	66.8	67.1	67.5	67.7	67.9	68.4	68.8	69.0	69.2	69.4	69.6	69.3
12.0	50.7	55.7	57.0	58.0	58.9	59.7	60.4	60.9	61.4	61.9	62.4	62.8	63.1	63.5	63.9	64.3	64.5	64.8	65.3	65.8	66.0	66.2	66.4	66.5	66.2
13.0	47.5	52.4	53.6	54.6	55.6	56.4	57.2	57.7	58.2	58.8	59.3	59.7	60.0	60.4	60.8	61.2	61.5	61.7	62.2	62.7	63.0	63.2	63.4	63.5	63.3
14.0	44.6	49.4	50.6	51.6	52.5	53.3	54.1	54.6	55.1	55.7	56.3	56.6	57.0	57.4	57.8	58.2	58.5	58.8	59.4	59.9	60.1	60.3	60.6	60.6	60.4
15.0	41.8	46.6	47.8	48.7	49.6	50.5	51.2	51.7	52.3	52.9	53.5	53.9	54.2	54.7	55.1	55.5	55.8	56.1	56.6	57.1	57.4	57.6	57.9	57.8	57.6
16.0	39.2	43.9	45.1	46.0	46.9	47.8	48.5	49.1	49.7	50.3	50.9	51.2	51.6	52.0	52.5	52.8	53.1	53.4	54.0	54.5	54.8	55.1	55.4	55.2	55.1
17.0	36.8	41.4	42.5	43.5	44.3	45.2	45.9	46.4	47.1	47.7	48.2	48.6	49.0	49.4	49.9	50.2	50.6	50.9	51.5	52.0	52.3	52.6	52.9	52.7	52.6
18.0	34.5	39.0	40.1	41.0	41.9	42.7	43.4	44.0	44.6	45.3	45.8	46.2	46.6	47.0	47.5	47.8	48.2	48.5	49.1	49.6	49.9	50.2	50.5	50.3	50.2
19.0	32.4	36.8	37.8	38.7	39.6	40.5	41.1	41.7	42.3	43.0	43.5	43.9	44.3	44.7	45.1	45.5	45.8	46.1	46.8	47.2	47.6	48.0	48.2	48.0	47.9
20.0	30.4	34.6	35.7	36.6	37.4	38.2	38.9	39.5	40.1	40.7	41.2	41.6	42.0	42.5	42.9	43.2	43.6	43.9	44.6	45.0	45.4	45.7	45.9	45.8	45.6
21.0	28.6	32.7	33.7	34.5	35.3	36.1	36.8	37.4	38.0	38.6	39.1	39.5	39.9	40.3	40.7	41.1	41.4	41.8	42.4	42.9	43.2	43.6	43.7	43.6	43.5
22.0	26.8	30.8	31.8	32.6	33.4	34.2	34.8	35.4	36.0	36.9	37.1	37.5	37.9	38.3	38.7	39.1	39.4	39.8	40.4	40.8	41.2	41.6	41.7	41.6	41.5
23.0	25.2	29.1	30.0	30.8	31.6	32.4	33.0	33.6	34.2	34.8	35.2	35.6	36.0	36.4	36.8	37.2	37.5	37.9	38.5	38.9	39.3	39.7	39.8	39.6	39.5
24.0	23.6	27.5	28.4	29.1	29.9	30.6	31.2	31.8	32.4	32.9	33.4	33.7	34.1	34.6	35.0	35.3	35.7	36.0	36.7	37.1	37.5	37.9	37.8	37.7	37.6
25.0	22.2	26.0	26.8	27.6	28.3	29.0	29.6	30.1	30.7	31.3	31.7	32.0	32.4	32.9	33.2	33.6	33.9	34.3	34.9	35.3	35.7	36.1	36.0	35.9	35.8
26.0	20.9	24.5	25.3	26.0	26.7	27.4	27.9	28.5	29.1	29.6	30.0	30.4	30.8	31.2	31.5	31.9	32.2	32.6	33.2	33.6	34.0	34.4	34.3	34.2	34.1
27.0	19.6	23.2	24.0	24.7	25.3	26.0	26.5	27.0	27.6	28.1	28.4	28.8	29.2	29.6	30.0	30.3	30.7	31.0	31.6	32.0	32.4	32.7	32.6	32.6	32.4
28.0	18.4	21.9	22.6	23.3	24.0	24.6	25.1	25.6	26.1	26.6	26.9	27.3	27.7	28.1	28.4	28.8	29.2	29.5	30.1	30.5	30.9	31.1	31.1	31.0	30.9
29.0	17.3	20.7	21.4	22.0	22.7	23.3	23.7	24.2	24.7	25.2	25.6	25.9	26.3	26.7	27.0	27.4	27.7	28.1	28.6	29.0	29.4	29.6	29.5	29.5	29.4
30.0	16.2	19.5	20.2	20.8	21.4	22.0	22.4	22.9	23.4	23.8	24.2	24.6	24.9	25.3	25.7	26.0	26.4	26.7	27.2	27.6	28.0	28.1	28.0	28.0	27.9
																								PDD 6 MV	
PSF	1.000	1.002	1.003	1.007	1.012	1.016	1.021	1.025	1.028	1.031	1.033	1.036	1.039	1.040	1.041	1.043	1.044	1.045	1.048	1.051	1.054	1.057	1.060	1.063	1.067